SOIL CONSERVATION

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The SOIL CONSERVATION APPROACH TO PROPER LAND USE

BY C. B. MANIFOLD[1]

ON 165 demonstration projects, more than 350 C. C. C. camp areas, and 4 public-land watershed projects, the Soil Conservation Service has brought about a 14-percent decrease in land under cultivation and a 29-percent decrease in rate of stocking ranges. At the same time, it has pointed the way toward an ultimate correction of many land abuses.

The first work of the Service was to demonstrate how changes in land use and mechanical practices, with better use of vegetation, can effect a reduction in accelerated erosion. More than 60,000 farmers in private land project and camp areas are cooperating with the Service in the endeavor to conserve moisture, control erosion, and make proper use of each acre of land. Surveys of soil conditions, of erosion, and of farm organizations have been made on each farm under cooperative agreement—this to assure that the changes indicated and installed would put the farm in condition for maintaining and improving its productivity on a permanent basis. In making changes in land use, full account is taken of the needs of the livestock which should be kept on the farm.

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Land uses in practice on 11,402,452 acres at the time the cooperative agreements between the farmers and the Service were signed, and the changes necessary to bring about proper land use are indicated in tabular form below.

These data are also shown graphically in the illustration.

Land-use changes

Land use	Before agreement	After planning	Changes in acreage
	Acres	*Acres*	*Percent*
Cultivated	5, 439, 308	4, 641, 484	14.7 decrease.
Orchard and vineyard	38, 176	39, 280	2.9 increase.
Permanent hay	202, 701	501, 723	147.5 increase.
Pasture and range	3, 931, 208	4, 238, 354	7.8 increase.
Woodland	1, 484, 048	1, 785, 752	20.3 increase.
Idle, miscellaneous	543, 040	431, 888	20.5 decrease.
Total (under agreement).	11, 638, 481	11, 638, 481	

The program of the Service provides for taking out of cultivation all severely eroded and gullied land and steep slopes subject to such erosion, and the planting of this land to a permanent cover of grass or woody vegetation. Of the 5,439,308 acres in cultivation when the agreements were signed, provision was made for converting 903,325 acres, approximately 16.6 percent, to other uses shown in tabular form on the next page.

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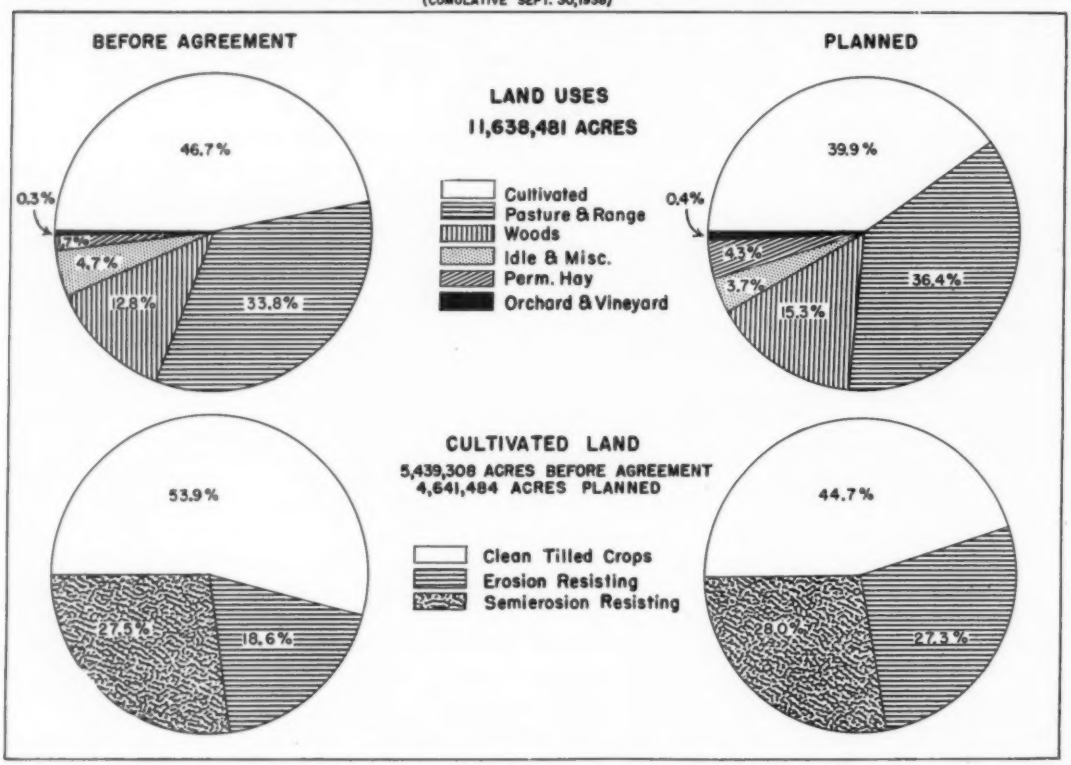
SUMMARY OF LAND USES BEFORE AND AFTER PLANNING
(CUMULATIVE SEPT. 30, 1938)



	Acres
To orchards and vineyards	1,862
To permanent hay	305,302
To permanent pasture	452,226
To woodland	135,964
To other uses	7,971

Incidentally, as certain areas of pasture, woods, hay, and idle land were found suitable for cultivation and appeared to be needed for this purpose these areas were converted to cultivated crop production; approximately 105,501 acres have been so converted. The soil conservation program therefore involves a net reduction of approximately 14.7 percent in the land under cultivation. This is only an average figure and cannot safely be applied to each farm as operations are carried out in this Service. A considerably larger reduction should be made to effect ideal land use. In many instances, especially on small farms without sufficient cropland to maintain an acceptable standard of living, it is not practicable to effect such a large percentage reduction in the acreage of cash crops.

On the other hand there are many instances, as in the case of the large wheat farms of the Palouse country of the Northwest, where reductions of 25 percent or more in cultivated acreage were feasible. It was found that 25 percent of this acreage in the Palouse country consisting of the clay hilltops and the steepest and most erodible slopes, was producing only 15 percent of the crop at about 35 percent of the total cost. Obviously a big measure of erosion control and also more profitable crop production were effected where such land was retired to a perennial cover of alfalfa and grass.

A total of 204,805 acres, or approximately 6 percent of the pasture acreage as of the time of signing agreements, were unfit for continued use for grazing, and plans have been made for converting such land to woodlands. This, together with other conversions, resulted in an increase of approximately 20.3 percent in woodland acreages, most of the increases being accounted for through the development of small wood lots on nearly every cooperating farm. While these woodland areas have been planned for the production of lumber, posts, fuel, and as windbreaks, their use for wildlife protection also has been given consideration.

Planting to trees in 1935, with protection from grazing during the following 3 years, has converted this nearly worthless pasture in Muskingum County, Ohio, from an extreme erosion hazard to a haven for soil, water, and wildlife.

On quite a number of farms special areas have been set aside for wildlife. These areas are usually odd corners in fields, gullies, borders along fences or woodlands, etc. While in most cases these areas are too small to be accounted for in the tabulation of land-use changes, they are so distributed as to make the whole farm available to wildlife. Besides these small areas approximately 13,260 acres have been planned for wildlife use, thus ensuring a valuable contribution to wildlife in addition to adequate erosion control.

Along with the adjustments in land use, the cooperative agreements provide for certain improved land-management practices. Cultivated lands representing approximately 46.7 percent of the total acreage, and subject to the severest erosion, naturally have been given the greatest consideration. Provision has been

Protection from grazing for 6 years has killed out the snakeweed, restored a vigorous stand of grass in Dona Ana County, N. Mex. Similar results are obtained by stocking at the correct carrying capacity.

made for contour tillage, strip cropping, cover crops, soil amendments, and in a great many cases, terracing in combination with any one or a number of these practices. Definite crop rotations have been developed which provide a balance between feed, cash, and hay crops and at the same time reduce to as great a degree as possible the acreage in crops requiring clean cultivation. A definite trend is shown in the program pointing to a reduction of some 859,447 acres, approximately 29.8 percent, in clean-tilled crop acreage. This reduced acreage was offset through the increase of crops that are partially erosion-resistant, such as small grains and annual hay crops, and erosion-resistant crops such as perennial hay crops. The increase in the hay production program serves to ensure against the overgrazing of permanent pastures early in the spring, late in the fall, and during periods of drought.

The grazing of pastures and range lands according to the carrying capacity of the perennial vegetation is a fundamental concept in the program of the Service, and is most effective in maintaining the productivity of the soil and providing nutritious forage. In the case of all forage grasses there is a most favorable method of grazing, which provides forage to be used during the immediate season, ensures perpetuation of the stand and future production, and protects the soil from accelerated erosion. Grazing which allows too little top growth limits root growth, and in turn limited root growth checks top growth. The result of such grazing is that forage for the season is less abundant than it should be, and the storage of an adequate plant food reserve in the roots to start vigorous growth the following spring is prevented.

On private land areas in the humid sections, where there has been increased production of erosion-resistant and semi erosion-resistant forage crops, practically no reduction in stock has been necessary. Such increased production is largely the result of better crop rotations including more legumes, soil amendments such as lime, manure and commercial fertilizers, water conservation practices, and reduced losses of surface soil.

In the four western watershed areas which include approximately 90 percent of public and Indian-owned lands, it has been necessary to plan for adjustment of stock to the carrying capacity of the range. On 6,010,880 acres, where range-management plans have been put into effect, there has been a reduction from 142,016 to 100,538 animal units, or 29 percent. Similar reductions in the rate of stocking have been made on privately owned range land in other Service work areas in the West. On these areas sufficient practicable pos-

A desirable distribution of close-growing and clean-tilled crops, woodland and pastures in South Carolina. Contour strip cropping, contour orchard planting, and terracing are helping to effect soil conservation and flood control.

sibilities do not exist for increasing the grazing area and/or increasing the production of supplemental feed. Hence, a reduction in numbers is the only method applicable to restore the stand and vigor of those grasses which provide the best feed and the best protection for the soil. Reductions in numbers of livestock are more than offset by smaller death losses, larger calf and lamb crops, greater weights at weaning time, and better prices per hundred weight.

A program designed to change an exploitative or speculative type of agriculture to one of stability and permanence must take into account all factors relating to the use of the land. It must involve in particular the physical features of the soil, including the degree and rate of erosion for each field and parcel of land. It must include careful studies of the capabilities of each field and parcel of land for the production without accelerated erosion of cultivated crops, pasture, permanent hay, woodland, and wildlife. The best species and strains of plants must be determined, not only from the standpoint of production but from the standpoints of persistence, and erosion-control and soil-building values. The safest and most effective practices relating to water conservation are of utmost importance; and proper fertilization, tillage, harvesting, handling of crop residues, grazing, and mechanical measures for the control of run-off must be put into operation on a permanent basis. Extremely important also is close consideration of the economic and social statuses and needs of farmers and operators.

A definite crop rotation, followed from year to year with ample provision for soil-conserving and soil-building crops, goes a long way toward stabilizing crop production and avoiding huge surpluses of cash crops which result from speculative plantings. A farmer who agrees to follow such a crop rotation and who produces a large part of his food, including livestock products, on his own farm is in a much better economic position during years of superabundant crops resulting from unusually favorable climatic conditions.

Wildlife in its relation to soil conservation and better land use will be the theme of a special issue of SOIL CONSERVATION next month.

MEASURING THE EFFECT OF LAND USE ON EROSION

By H. L. Thomas, I. J. Nygard, and L. E. Bullard[1]

THE primary purpose of a detailed soil conservation survey is to obtain specific information for use in planning an erosion-control program for an individual farm. However, it can be made to serve another purpose—that is, to provide general information that will be of value in future planning.

Technicians on the Beaver Creek erosion-control demonstration area in southeastern Minnesota have developed a practical method of obtaining and analyzing this information as it applies to the effect of land use on erosion. The method and results are reported in this paper with the idea that it may be used effectively on other areas. This system should be especially applicable on small watersheds.

In making the survey the surveyor starts at a given point on the farm which he is studying, walks over each field and, with a soil auger, examines the soil and determines the extent of erosion at frequent intervals. He also observes the slope of the land and notes the use made of the land. This information is recorded on an aerial photograph used as a base map. A complete map shows as accurately as possible the soil type boundaries, cover or land use, slopes, and different degrees of erosion. Standard symbols are used on the erosion survey map to denote the various classifications of slope, extent of erosion, soil type, and land use.

To determine the average depth of the A horizon of every soil type a careful examination must first be made of the soil profiles of virgin areas. The degree of erosion is then ascertained by estimating the number of inches of topsoil (A horizon) that has been removed from a given field or area as compared with the virgin soil under similar topographic conditions.

Next comes an analysis of the information recorded on the survey maps. The first step used in securing the results presented in this paper was to list on separate cards the complete symbols for all areas that had been worked out on the map. For example, one card was made for the area $\frac{16\text{–L}}{\text{BB–3}}$, one for $\frac{16\text{–L}}{\text{A–2}}$, etc. This listing was completed for all the land surveyed, making a total of 5,304 cards, each representing one separately classified parcel of land, or in other words, one set of observations. No attempt was made to obtain the area of these parcels of land.

The second operation was a classification of the cards. They were separated and arranged in groups representing the cultivated, open-pasture, and forest sites. Each site group was then divided into the five slope groups, and the final assortment consisted of a classification of each slope group into five erosion classes. Totaling the number of cards in each of these final groups, the frequency of occurrence was obtained for each class of sheet erosion under any given set of conditions. From these data it was possible, for example, to determine the percentage of cases of 4 erosion on BB-slope cultivated land, and to compare it with the percentage of cases of 4 erosion on BB-slope forest land.

One final calculation was performed in order to arrive at the data presented in this article. The average number of inches of topsoil lost on A-slope cultivated land was calculated, also that on B-slope cultivated land, and so on through the whole list of groups. These figures were obtained by multiplying the middle value of each erosion class by the frequency or number of observations and dividing by the total number of observations. The middle value for erosion class 1 was obtained by multiplying by one the typical virgin depth in inches of the soil type involved, for erosion class 2 by multiplying the virgin depth by 12.5 percent, for erosion class 3 by multiplying the virgin depth by 42.5 percent.

The following example of a calculation will help to make clear the method used in estimating the inches of topsoil lost on the basis of the classified observations which were drawn from the survey maps:

Erosion class	Column I Number of observations placed in each erosion class in the case of cultivated Tama silt loam on B (3–7 percent) slope	Column II Factor obtained by multiplying the middle value of each erosion class by 12 inches or the typical virgin depth of Tama silt loam. This figure represents the inches of topsoil removed	Column I multiplied by column II
1	21	0.0	0.0
2	213	1.5	319.5
3	8	5.1	40.8
4	0	8.4	0.0
Total	242		360.3
Average number inches topsoil lost on cultivated Tama B slope (found by dividing 360.3 by 242)			1.49 in.

[1] Project agronomist, project soils technician, and assistant project soils technician, respectively, Soil Conservation Service, Caledonia, Minn.

The effect of land use on erosion in Beaver Creek watershed

Slopes	Average amount of topsoil lost from—			Number of observations recorded on—		
	Cultivated land	Pasture	Forest	Cultivated land	Pasture	Forest
	Inches	*Inches*	*Inches*			
A (0 to 3 percent)	0.06	0.07	0.00	216	42	16
B (3 to 7 percent)	1.87	.58	.15	675	149	82
BB (7 to 15 percent)	4.14	.90	.07	1,528	362	285
C (15 to 25 percent)	4.52	1.25	.04	834	410	339
D (above 25 percent)	4.69	.98	.06	61	112	193
Average [1] or total	3.51	.96	.07	3,314	1,075	915

[1] The averages were obtained by totaling inches of soil lost in each observation and dividing by the total number of observations.

One distinct advantage of this method of studying the erosion problem is that it deals with conditions as they steadily exist in the field. Someone may raise the criticism that it is not possible to measure the inches of topsoil lost over a large area nearly as accurately as the data would indicate has been done by the investigators. It must be realized, however, that, strictly speaking, any quantitative measurement is no more than an estimate; and the writers believe that by estimating soil loss a great number of times and as accurately as possible, and then taking the average, an accurate appraisal can be approached. It should be noted that the losses are progressively greater as the slopes become steeper and also as the natural state of the land is more disturbed. This is the result that can be expected, and is an indication that the data give an accurate picture of the true situation as it exists in the field.

On cultivated land an average of 3.51 inches of soil has been removed, while in open pastures only 0.96 inch is gone, and in forested land practically none. The gullied areas were also much more frequent in the cultivated fields. Gullies were found on 17.6 percent of the cultivated sites and on only 4.6 percent of the open pasture sites.

The low figure, 0.06 inch for cultivated fields on A slopes, may need an explanation. On 207 of the 216 observations on these relatively smooth and level fields no measurable erosion was recorded. That is, no definite soil loss was noticed in measuring the depth of the A horizon on these 207 fields and comparing them with the depth of the A horizon on virgin or nearly virgin fields. Averaging these observations recorded as "no soil loss" with the nine showing definite soil loss gives this low figure. The writers are aware that accelerated erosion takes place on these relatively level fields, but were not able to record the small loss. The same explanation applies to the low figures presented for losses under forest cover.

In addition to the information relative to the effect of land use, the table clearly shows the effect of slope of the land on sheet erosion. On the cultivated land in particular the losses are progressively greater on the steeper slopes.

A question may be raised as to why, on cultivated land, there has not been a much greater soil loss on D slopes than on C slopes, and on both C and D slopes as compared with BB slopes. The old settlers in the watershed relate that, in general, the land on the lesser slopes was the first to be broken from its virgin state on all farms. As more land was needed, steeper land was farmed. Possibly this situation will explain the fact that the losses on the most severe slopes have not been so great as one might expect. The same explanation will probably hold regarding the pastured land, since the steeper areas afford poorer grazing and would be used only after no other land was available.

Deferred Spring Grazing

Deferred spring grazing, often spoken of as range or vegetative readiness, signifies complete protection of pastures from grazing until the growth and development of the foliage has made a good start. After the dormant season herbaceous vegetation makes all new growth from the food stored in the roots. If this food supply is to be available each year the plant must be maintained in a vigorous and healthy condition. This condition is influenced by the number of days of full protection from grazing given to the range after growth starts. Sufficient time should be allowed for the desirable perennial species to produce enough foliage to provide a food supply for the current growth when being grazed. If healthy plants are protected from all grazing for from 10 days to 2 weeks after growth starts, the leaf production can usually keep ahead of the rate of cropping, provided the range is properly stocked.

Every acre of the grazing area should be so treated each and every year. This is a fundamental range-management practice that is necessary for soil and water conservation, range improvement, and maintenance.—*Liter E. Spence.*

Depth of Moisture and Yield of Wheat

By R. R. Hinde[1]

RECOGNIZING that moisture is a limiting factor in wheat production in the Southern Great Plains, the Soil Conservation Service technicians in the project and camp areas are assisting farmers in their crop planning by taking soil samples to determine the depth and amount of moisture accumulations in the soil.

The average rainfall in the Southern Plains is approximately 18 inches but the variance during individual years is wide. As a whole, the area is highly favored in the distribution of annual rainfall, approximately two-thirds of the moisture coming from April to September, through the summer growing season. Moisture available during this growing period points to but one conclusion—that greater crop utilization can be made of the moisture that falls than has been done in the past.

In the Great Plains, where crop production is carried on under low annual rainfall conditions, the loss by run-off and evaporation of 9.3 inches of this moisture is a serious handicap in the production of a wheat crop. Only that retained in the soil and saved from loss by run-off and evaporation is available for plant use. Contour farming operations, supported by terraces and tillage practices that will increase the absorptive capacity of the soil and thus reduce the run-off and evaporation, are valuable in retaining moisture that otherwise might be lost.

Late plowing, listing, and one-waying are unsatisfactory methods of preparing a seedbed for wheat. These methods permit large losses of moisture through weed growth after harvest; also, a poor seedbed is usually the result of such practices. The seedbed which is prepared late is often dry, loose, and in poor tilth. Early listing, followed by a ridge-buster and a duck-foot cultivator later, has proved satisfactory from the standpoint of moisture conservation and good seedbed preparation.

The difficulty in producing wheat in the Great Plains is that the wheat farmer must prepare his seedbed and do his planting at least 9 months in advance of harvest. During this time rains may come, or they may not, resulting either in a profitable crop or loss of a crop. For this reason, wheat farmers continue to seed wheat in the fall and take a chance on making or losing a crop. A flexible cropping system, which takes into consideration the soil moisture and fertility conditions of the field at each planting time, should be used where wheat is grown. Where this plan is used, a crop should be planted only when the moisture and residues are favorable—this in order that some assurance may be had of a profitable production and a vegetative cover for the land. It has been definitely determined by experiment stations in the Great Plains that the best land use and the highest economical returns can be secured by normal planting with favorable subsoil moisture conditions at planting time. In the case of wheat planting, 24 inches of moisture depth at seeding time is considered a safe margin. When moisture and residues are lacking, wheat should not be planted, or at least the acreage should be materially reduced. Soils of the Great Plains, where moisture is the limiting factor in crop production, are usually high in plant food content and have lost very little fertility due to leaching and removal by crops. The fertility, as a rule remains relatively constant and does not require regular cropping rotations, addition of commercial fertilizers, or the growing of legumes to restore nitrogen. Nitrogen is largely supplied in the western soils by the action of nitrogen-fixing bacteria living in the soils on decayed organic matter. The returning of crop stubble and residue to the soil, to replenish the organic content, is important in western agriculture.

As a result of studies made over a long period of time, A. L. Halsted and O. R. Mathews of the Division of Dry Land Agriculture in the Department have devised a method whereby the wheat farmer can forecast, fairly accurately, his chances of producing a profitable wheat crop. These two men discovered that the moisture already in the soil at planting time is a reasonably accurate index to the next year's harvest, and that the rains coming between seeding time and harvest time have little effect upon the yields of wheat.

These results and fact-finding data, which Halsted and Mathews compiled at the various dry land experiment stations, are something that the wheat farmer may use on his own farm in order to determine his chances of a profitable crop. By the simple use of a posthole digger, tile spade, or soil auger, the

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Harvesting Wheat with Combine, on Contour, Followed by One-way Disk Plow, Cutting and Mixing Stubble with Surface Soil. Conservation of Crop Residues is an Effective Wind-erosion Control. Immediate Disking of Stubble After Harvest Saves Moisture for the Next Crop.

depth of moisture in the soil may be determined. If the depth is less than 24 inches, a favorable wheat crop is uncertain.

If this practice is used by the wheat farmers every year there will be fewer wheat failures, and also an expansion of other crops planted as substitutes for wheat.

By the use of such soil-moisture tests the farmer may be able to decide early in the spring whether or not the wheat crop planted in the fall should be abandoned or left on the land for harvest. In the case of abandonment, the land may be prepared for another crop; or it may be summer fallowed early enough to prepare a good seedbed and conserve the early spring rains.

Probabilities of obtaining specified yields of wheat in soil dry or wet to designated depths at seeding time, as determined by the Division of Dry Land Agriculture, U. S. Department of Agriculture, Hays, Colby, and Garden City, Kans.

Depth of moisture at seeding time	Percentage of chances of obtaining specified yields				
	Failure	5 to 10 bushels	10 to 20 bushels	20 to 30 bushels	30 or more
Soil dry	71	11	18	0	0
Wet 1 foot	34	23	24	19	0
Wet 2 feet	34	23	24	19	0
Wet 3 feet	10	6	14	47	23

Observations of 84 wheat crops from 1924 to 1937, made by H. H. Finnell at the Panhandle Agricultural Experiment Station, Goodwell, Okla., showed that a forecast of wheat yields could be approximated by considering four factors previous to or at the time of seeding. These factors are (1) July rainfall, (2) soil moisture depth in the fall, (3) amount of available nitrogen in the soil, and (4) the amount of unrotted vegetable matter in the soil.

Where all 4 factors were favorable, 6 crops produced 30 bushels; where 3 factors were favorable 16 crops produced 20.5 bushels; where 2 factors were favorable 23 crops yielded 9.5 bushels; where 1 factor was favorable 34 crops yielded only 1.25 bushels, and where no factors were favorable 5 crops yielded one-third bushel. A summary in tabular form of field tests made at Clovis, N. Mex., Vega, Tex., Liberal, Kans., Hereford, Tex., and Perryton, Tex., is presented below. The table shows percentage of fields falling in each soil-moisture depth classification.

Yields (bushels per acre)	Soil-moisture depth				
	0 to 6 inches	6 to 12 inches	12 to 24 inches	24 to 36 inches	36 to 42 inches
	Percent of fields	*Percent of fields*	*Percent of fields*	*Percent of fields*	*Percent of fields*
Failure	18	36	50	31	.....
1 to 5	13	8	10	14	10
6 to 10	41	24	12	17	10
11 to 15	19	13	17	22	30
16 to 20	9	11	10	10	30
21 to 25	.....	8	1	5	20
26 to 30	.....	.....	.....	.....	.....
31	.....	.....	.....	1	.....
	100	100	100	100	100

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ARROYO CONTROL AND REVEGETATION IN ARIZONA

By E. L. Beutner[1]

STUDIES were begun, in 1936, in Arizona with a view toward developing methods of controlling arroyos and revegetating valley alluvial flats in the Southwest, especially under conditions found in the southern part of Region 8. These areas at one time furnished abundant feed for cattle, in many instances supporting heavy stands of wild grass which was often cut for hay. The alluvial flats range in size from small elongated areas which rise at the foot of mountains and extend in fan formation toward the central part of intermountain valleys, to broad alluvium-filled valleys which form major stream tributaries. In most cases the alluvial flats are now drained by vertical-walled arroyos of recent origin. These arroyos are gradually encroaching throughout the flat areas to dissect them completely and produce a "bad-land" condition. While the soil consists of deep alluvial deposits, the more friable surface soil, together with the grass cover, has been removed by erosion so that a highly erodible soil is left exposed. During wet weather this soil puddles and seals over to such an extent that very little moisture penetrates. As a result, only deep-rooted shrubs and a few annual weeds are supported; this allows both gully and sheet erosion to proceed at a constantly accelerated rate.

Not only is the productive rate of these alluvial flat areas being diminished, but their erosion is furnishing an even greater menace to agricultural lands, irrigation ditches, and storage reservoirs. Studies of the silt content of run-off waters in the Upper Gila River drainage basin indicate that at least 20 percent of the silt load of the Gila River is contributed by one tributary—the San Simon Valley, which is a typical example of a large alluvium-filled valley cut by a recent arroyo. In addition, hundreds of smaller drainage-ways are tearing out the thick alluvial deposits of smaller valleys and dumping them into the main stream channels.

In many instances the beginning of gully erosion may be traced to poor land management with too great concentration of livestock and trampling and over-utilization of vegetation. Many of the arroyos, however, started from ruts of old roads and trails, and a few are the result of plowing and later abandonment of formerly sodded areas. The problem as it now stands is to devise methods by which gully cutting may be checked and, at the same time, to rehabilitate the land, wherever potential values exist, so that vegetation may become reestablished.

Brush Spreaders Retard Run-off, Increase Soil Moisture, Contribute to Vegetative Growth.

The area selected for the study lies south of the city of Safford, Ariz. Here a small wash originates in the foothills of the Graham Mountains, and extends northward for 2 miles through relatively rough country. At this point there is a change of gradient and the stream breaks into a vertical-walled arroyo which cuts through a broad alluvial flat. Several smaller arroyos also traverse the flat, making for very rapid concentration of water and run-off after a rain. The

[1] Project supervisor, division of research, Soil Conservation Service, Safford, Ariz.

Diversion Dam Bridging an Arroyo, Diverting Water to Flat Lands, Effectively Backing up 10 Acre-feet of Silt.

area of the entire watershed is 3,014 acres of which 456 acres lie in the alluvial flat. Before the cutting of the arroyo, water which entered the flat area from the watershed above was spread naturally and contributed to an abundant growth of alkali sacaton (*Sporobolus airoides*) and tobasa (*Hilaria mutica*). Little concentration of water took place, so that irrigation canals and farm lands below were not seriously menaced by floods and loads of debris.

To check erosion of the arroyos and prevent further silt from being carried down, a number of earthen diversion dams were constructed. These dams divert flash floods from the arroyos to the remaining flat lands and also cause silting up of the arroyos themselves. A series of contour spreaders was installed to provide an even distribution of water and prevent further erosion on the flat lands. Several types of spreaders were used including wire spreaders where the volume of water was great, brush spreaders where lesser quantities of water were dealt with, and earthen spreaders where local gullies and uneven ground occurred. Two years' results have shown that this system of structures is effective in caring for flood waters as well as starting the filling of the arroyos. Since the life of these structures is limited, however, it is necessary to reestablish a vegetative cover to complete the stabilization of the area. The area had been denuded of all vegetation except a few shrubs such as creosote bush (*Larrea tridentata*), mesquite (*Prosopis juliflora*) and salt bush (*Atriplex polycarpa*), and it was apparent that artificial revegetation methods would have to be used to obtain a grass cover that would be effective in controlling erosion.

Earlier experimental work in reseeding denuded areas of this kind had indicated that little success can be expected unless the surface of the soil is loosened to allow better penetration of water and to create more favorable conditions for seed germination. Several methods for creating this condition were attempted. The first method, which also produced most rapid results, consisted of spreading native-grass straw containing some seed over the bare compacted soil and disking it in. This created a mulch which not only increased the absorptive and retentive power of the soil but also established the seed which otherwise would have been blown or washed away. As a result of this treatment an abundant growth of vegetation, consisting chiefly of annual grasses and weeds but also a few perennial grasses, took place during the first season.

This cover of annual plants which included purslane (*Portulaca oleracea*), annual grama (*Bouteloua barbata*) and (*B. aristidoides*), fingergrass (*Chloris virgata*) and pigweed (*Amaranthus palmeri*) provided a further check on erosion and rapid run-off and served as a nurse crop while the more desirable range grasses became established.

After the second year a number of perennial plants had established themselves in areas which had been reseeded. Among these plants which give promise of forming a permanent cover are sacaton (*Sporobolus wrightii* and *S. airoides*), rothrock's grama (*Bouteloua rothrockii*), chamizo (*Atriplex canescens*), feathergrass (*Andropogon saccharoides*), vine mesquite grass (*Panicum obtusum*), and Johnson grass (*Sorghum halepense*). In addition, a number of introduced species including African bunchgrass (*Eragrostis lehmanniana*) and reedgrass (*Phalaris tuberosa*) are showing satisfactory results.

A second method which was used to establish vegetation involved disking seed into the bare soil without use of straw mulch. This method, while not as effective as that using straw, provided for the establish-

(*Continued on p. 202*)

Range Utilization Surveys and Procedures for Follow-up

By J. L. Lantow [1]

The grass on the left side of the fence has reached a higher volume growth, due to full protection from grazing. Proper management will produce similar results in the composition and density of the stand of desirable forage grasses. The grass on the right side has been heavily grazed by Navajo sheep.

IT is common knowledge that the range lands of the West have deteriorated as a result of the use and management to which they have been subjected in the past. It is equally well known that erosion has accompanied and followed this deterioration. For the permanent rehabilitation of our ranges therefore we must first change or modify the management and use; and this change with the establishment of the basis of proper use, provides our Service the key to conservation operations planning.

Range management practices have varied greatly in different parts of the West, but for convenience they may be grouped in two general areal classifications as follows:

1. Areas where some period or seasonal use is forced upon the operators by physical and climatic conditions.
2. Areas where yearlong grazing could be practiced.

In the sections where bunchgrass and browse dominate and where cold temperature and snow are factors to be contended with, the livestock management generally operates in separate winter and summer grazing units. But in the sod-grass areas, under similar climatic conditions, pasturing on wheat fields or stubble is practiced, or lot feeding, during fall and winter months. In both the bunchgrass and the sod-grass areas, a period or seasonal use forces itself into operation.

The operators, however, when using these grazing units by periods or seasons, have not always considered that there is a proper time of range readiness when livestock should be taken off or put on a range. The readiness of a range may be influenced by physical conditions of the soil, such as too much moisture, or by climatic conditions which may affect the growth of the plants and hold back or accelerate their readiness for use. And there may be many other reasons for timely changes in grazing. In sections of the West where yearlong grazing is practiced it usually is not only necessary to adjust numbers of livestock, but rotation or deferred grazing should be installed in the management plans. The two practices are equally important.

For the successful establishment, by artificial revegetation, of a perennial grass cover on denuded and depleted ranges a system of management must be initiated to allow the young seedlings at least one or two growing seasons without grazing. With several pastures, or a proper system of grazing, a seasonal rotation plan may be used to give protection to such areas for the necessary time. The rotation grazing may thus be planned with a progressive seeding program. The total area to be revegetated may be divided into smaller areas which will be seeded in successive planting seasons.

There are many factors in livestock management which may be incorporated into operations for the financial benefit of the operator and the protective benefit of the range. A management plan is essential, and it should include the basic factors of proper management for the locality. This does not mean, how-

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ever, that changes, modifications, and adjustments are not to be made as operations indicate that they are needed. The plan and the estimated numbers of livestock should be considered as only the beginning of the program. Any specific plan must be adjusted to changes forced upon us by unpredictable natural conditions. Likewise, we shall often wish to correct mistakes or to incorporate better practices.

In studying our operations, we shall in the future always consider such items as (1) methods of use, (2) time of use, (3) intensity of use and (4) forage or feed reserve necessary and advisable. These items surely point to a constant and continuous study of the range business. In our work with the operator, we might call these observations "performance checks" or "follow-ups." In making these observations we have an unusual opportunity to acquaint the operator with the program as a whole, to guide and instruct, and to work with him in analyzing performance.

In relation to this part of the work it will be helpful to list points to be considered in the range follow-up, or observance of performance activities. These important points are:

1. To secure the best possible vegetative cover that is consistent with economical management and the proper conservation of soil and water.
2. To consider control measures, such as structures, to be installed as justified by anticipated benefits.
3. To evaluate existent range practices and conditions by means of range utilization surveys.
4. To instruct the operator in the factors of scientific principles underlying plant care or management and livestock production. Guidance in the management of range and livestock must accompany the instructions so that the operator will understand the correlation of plans and practices. Records of livestock sales, purchases, increases, times of movement, and death losses for pastures and for the ranch as a whole should be kept up to date so that data can be put to immediate use when adjustments are needed.

It has been noted above that range utilization surveys should be included in performance activities. This should be emphasized, as there is no better way to establish proper stocking than by observing the use of a pasture or ranch. The same amount of feed is not grown year after year on a pasture or ranch, nor is there a very well established percentage of fluctuation in production. It is true, however, that we try in the beginning to establish a rate of stocking that is consistent with the quantity of forage available. In this we keep in mind the retaining of sufficient reserve not only to protect against erosion and allow for maintenance and recovery of vegetation but, also, to serve as a "back-log" for livestock during times of lessened forage production. A utilization survey, therefore, consists of finding out how the livestock numbers and the feed production will coincide for the duration of the total grazing period—not only for the ranch as a whole but for separate pastures as well. If we accept the old saying, "The eye of the master fattens the cattle," it should be doubly appreciated that "Eternal vigilance and observation allow timely adjustments to forestall erosion."

Utilization surveys would not be made at the same time in different parts of the country. On seasonal or year-long ranges they would probably be made at different times of the year. On any range, however, it would be well to take stock of forage and feed resources at the end of a production season. On grazing lands it is generally considered best to make the livestock fit the feed, since it is difficult to make the feed fit the livestock.

The relative palatability—percentage or extent of different species of plants—should depend largely upon two factors: (1) That if possible enough vegetation be left satisfactorily to handle erosion; (2) that the percentage of use between the different species be subject to change in different plant compositions so that the desired species will not be penalized. A greater percentage of use may be safely allowed on a good vegetative cover in heavy production years, and vice versa in years of light production. Each pasture should be analyzed on its own merits as to utilization.

In the method of procedure to be outlined in the following paragraphs, we attempt to make a diagnosis in the fall check so that we may estimate the number of livestock that can be safely kept during the winter and spring without damage to the range. Of course sufficient reserve must be kept somewhere on the ranch, at least enough to carry us until fall shipping in case no production follows. In making this estimate, we consider the amount of time the actual number of livestock were grazed, and also the percentage of forage use for the period. This necessitates the keeping of livestock records. The records should be kept by pastures as well as by the ranch totals. The method of procedure with the formula that may be used is shown on the following page.

The palatability, as shown in column 2 of the species tabulation, points out the percent of the species that will be eaten by livestock under proper range management. These percentages are arrived at by long and careful observation. Columns 4 and 5 represent the

percent of forage taken as of the first and second dates of inspection. The "percent of forage utilized" is determined by dividing the "utilization factor" of the first inspection by the total "palatability factor," and this is repeated using the "utilization factor" of the second inspection. The "actual animal months use" figures are determined from records kept by the operator.

There are many factors to be considered in making range utilization surveys. For convenience, the important ones are herewith listed:

1. The method of use on the area—yearlong, deferred, or rotation.
2. The variation in established palatabilities. These variations may be due to the combination of species within the pasture, or to the time of use.
3. The time element; that is, the amount of the time period that has been utilized previous to the surveys and the amount of the use period that remains.
4. Regrowth following the normal growing period.
5. Numbers, kinds, and classes of livestock.
6. Time of range readiness or condition.
7. Percentage of use of principal palatable species.
8. Cut in carrying capacity for protection of soil and plant vigor.
9. Timely adjustments in management.
10. The amount of reserve left for erosion protection.
11. Any changes in pastures, boundaries, or acreages.

It is important that the work be done with the cooperator, prior to market periods, if at all possible. Findings from these use surveys should serve as a guide to the operator in handling his ranch. In going over the ranch for utilization surveys, he is given a chance to make timely adjustments in his management plans and to observe the use being given to the different plants. For example, he may find that he should change his palatability lists in relation to proper use, as indicated by the utilization in the composition of plants in a particular pasture.

The benefits of range performance work (follow-up work) have been stressed, but we should not fail to point out the qualifications for a man doing this job. A range examiner sent out on such work must have experience behind him, and he must have the necessary knowledge and understanding of ranching. He should be qualified by education and training. He should have a suitable personality and approach for dealing with ranchmen. He must have ample time to devote to the work.

It requires a great deal of time and thought to make a success of ranching and to handle the range so that

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SOIL CONSERVATION SERVICE RANGE UTILIZATION SHEET

Cooperator: John Jones.
Examiner: J. Doe.
Field No. 3, cow pasture.

Dates inspected	Oct. 15, 1937.
	May 1, 1938.
Average date growth begins	June 1.
Average date growth stops	Nov. 1.
Average number months in growing season	5.
Total number months in grazing year	12.
Estimated percent of normal forage production	90.

Species tabulation

Forage species	Composition of total perennial vegetation	Palatability	Palatability factor (palatability × percent of composition = P. F.)	Degree of utilization		Utilization factor (percent of utilization × percent of composition = U. F.)	
				First inspection	Second inspection	First inspection	Second inspection
	Percent	*Percent*		*Percent*	*Percent*		
B. gracilis	40	85	3,400	35	85	1,400	3,400
H. jamesii	15	60	900	50	80	750	1,200
S. cryptandrus	5	35	175	30	60	150	300
A. tridentata	15	20	300	5	20	75	300
Total	.....	.....	4,775	.....	.....	2,375	5,200

	First inspection	*Second inspection*
Palatability factor (P. F.)	4,775	4,775
Utilization factor (U. F.)	2,375	5,200
Percent of forage utilized	49.7	109
Actual number of animal months (A. M.) use	1,000	2,010

The total percent of forage utilized (109) × the animal months used at the end of the first inspection (1,000) ÷ the total animal months used (2,010) = the correct degree of utilization in percent at the end of the first inspection, or 54.

Total number of animal months used for the year: Recommended, 2,010; Actual, 2,010.

The recommended animal months of grazing remaining after the first inspection is expressed in the following formulas:

A. M. used 1,000 × (P. F. 4,775 − U. F. 2,375) ÷ U. F. 2,375 = A. M. use remaining 1,010

A. M. use remaining 1,010 ÷ months remaining 7 = number of animal units 144

By calculating in percent of proper use only:

A. M. used 1,000 : percent of growth or feed used 49.7 : : x : percent remaining for proper use (100 − 49.7 = 50.3) 50.3

x = number of A. M. for proper use remaining 1,012

A. M. remaining 1,012 ÷ months remaining 7 = number of animal units 144

Suggested palatability changes

Species	Present palatability	Suggested palatability	Reasons for change
H. jamesii	60	70	
S. cryptandrus	35	50	

Permanent Cover in Irrigated Orchards

By Charles B. Ahlson [1] and George Hutchinson [2]

IT is an accepted truth that a permanent cover of close-growing vegetation is of great value in controlling erosion. Dr. Bennett recently made this statement: "Close growing plants have emerged from all investigations as a fundamental principle of soil conservation. The use of vegetation will play a major part in the compromise which farmers eventually will work out with nature. Some compromise is necessary if crops are to be harvested and the productiveness of the land still maintained."

There are many questions yet to be answered, however, regarding the practical and economic limitations in the use of permanent cover. Can permanent cover crops of perennial and annual grasses and legumes be used in irrigated orchards in such a way that they will reduce erosion and cost of cultivation and at the same time maintain the average or more than average production and quality of clean-tilled or winter cover-cropped orchards? Will they increase the cost of pest control? Will they increase loss from rodents? Will they reduce production as the result of competition? Will such a system be practical in different localities and under varying climatic and physical conditions?

The following series of observations, made in various fruit-producing areas throughout California, are not intended to answer all these questions but are submitted as an indication that there is need for more research along this line.

Permanent Cover in Deciduous Orchards

Grower No. 1 has a Bartlett pear orchard, consisting of 3 acres. It is located at the end of Clark Street, half a mile south of Placerville in El Dorado County, Calif., in the center of a pear-producing area. The trees were planted in 1916 and have not been cultivated since that time. The trees are growing on slopes up to 30 percent. Twenty-five to fifty percent of the topsoil had been removed previous to the planting of the trees. The trees are normal and uniform in size, vigorous and of a dark green color.

The irrigation practice consists of "wild" flooding from furrows constructed across the slope, the water being spread by the dense permanent cover crop. The average seasonal application of irrigation water is about 20 inches per acre, and the cost is about $9 per acre.

The usual fertilizer practice consists of the application of about 400 pounds of ammonium sulphate per acre annually, at a cost of about $6 an acre.

The perennial grasses, legumes, and annual weeds are mowed with a scythe from time to time and the cuttings left in place to form a dense mat of protective covering. The green growth reduces the fire hazard to a minimum.

The production figures for this orchard, obtained from the packing house and including the years 1928 to 1937, show a range of from 877 packed boxes, the lowest production, to 1,795 packed boxes, the highest production in the 10-year period. The 1937 production was 1,512 packed boxes. The average for the 10-year period was 1,296 packed boxes.

The production of pears which were handled by the packing house during this 10-year period averaged approximately 200 packed boxes per acre, while the yield of this particular orchard for the 10-year period averaged 432 packed boxes, or better than twice the average yield.

The quality of the fruit was above average. This is shown by the income received per box. This exceeds the average for the packing house of 2 to 17 cents, and averages 8 cents per box more than the house average.

The grower is thoroughly satisfied with the results he is obtaining through the practice of permanent cover. He tells us that operation of this particular grove would not be practical if it were necessary to cultivate—this because of the excessive slopes on which the trees are growing. He reports that his operation costs are low and that it requires less irrigation labor with this type of "wild" flood irrigation.

Similar reports could be recorded on 3 other orchards in this area. The figures from these orchards indicate that the production exceeds the average by 100 to 200 packed boxes per acre, and that the quality is equivalent to or above average.

Grower No. 2 owns a Bartlett pear orchard consisting of 33 acres located 3 miles east of Placerville on Highway No. 395 near the village of Camino, El Dorado County, Calif. The owner formerly operated 130 acres of orchard in this parcel on which the production was strictly marginal, principally due to severe erosion caused by winter rainfall and irrigation water and inadequate infiltration of the water.

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In 1937 a new manager with considerable training in biochemistry was appointed and he abandoned approximately 100 acres of this planting and concentrated his efforts on the best portion, consisting of 33 acres. The slopes range from 3 percent to 25 percent, and the erosion was very active prior to 1937.

The new manager recognized that erosion and improper irrigation were probably responsible for the decline of the trees. In October of 1937 he seeded the 33 acres to ladino clover, vetch, and rye, and mulched the orchard with hay from an adjacent field of volunteer cover. Ammo-phos was applied at the rate of 400 pounds per acre. The fertilization resulted in an especially heavy cover crop and erosion was negligible, although 1.32 inches of rainfall occurred in 21 minutes during one storm. The planted cover crop was mowed once late in the spring of 1938, and all cultivation has been discontinued.

The manager states that irrigation has been greatly simplified and that there is practically no run-off of irrigation water this season. He intends to continue with permanent cover without cultivation and believes it is the proper program to follow in view of the results others have had with permanent cover throughout the past 20 years or more.

As a result of 1 year of this program the trees have improved in condition and the yield for the 1938 season is very satisfactory, considering the brief period of improvement. It appears, according to the manager, that an increase of at least 20 percent in yield was attained this year, although this may not be conclusive as it is a year of high yields in this particular area. The response and recovery of the trees are outstanding, however, and it is the belief of the management that the 33 acres can be completely rehabilitated and that profitable crops can continue to be produced under this system of permanent cover.

Ukiah, Calif., is located 115 miles north of San Francisco in a rich fruit-growing section. An efficiency study of Bartlett pears in this area, conducted by the Extension Service and reported in November 1936, shows an average yield of 6.9 tons of fruit per acre for the 14 pear orchards studied. The average yield of the 7 high orchards was 9.3 tons per acre, and that of the 7 low orchards was 4.1 tons per acre.

For comparison, it may be sufficient to record the practices and results of one permanent cover cropped orchard consisting of 12 acres of Bartlett pears planted in 1888. This orchard is located 7 miles southeast of Ukiah on the River Road. These trees are growing on bottomland and the soil is 6 feet or more in depth. Four of the twelve acres were reset in 1919. The owner practiced clean cultivation prior to 1923 and this orchard has been in permanent cover for 15 years.

The source of irrigation supply is the Russian River, and a normal annual water use is about 24 acre-inches. The owner reported that he had difficulty in obtaining penetration of the irrigation water when the grove was clean cultivated, and he observed the ease with which the soil took water when irrigating an alfalfa planting on an adjoining parcel. As a result of this observation, the grower decided to discontinue all cultivation in the pear orchard in order to establish a permanent cover of clovers, Italian ryegrass and some annual grasses and weeds. The grower does not mow this cover.

His fertilizer program consists of applying a small amount of sheep manure obtained from a band of sheep maintained on the farm, and, in addition, a small amount purchased from time to time from neighbors.

The trees are in very good condition and show a deep green color and uniformity of growth. During harvest season the land is disked very lightly between each row to eliminate the irrigation ridges. By this he is able to avoid bruising the fruit as it is hauled from the orchards.

Crop yields secured from the packing-house record on 9.31 acres of the total show that from 1926 to 1937 they ranged from a low of 15.7 tons per acre to 25 tons per acre and averaged 17.8 tons of pears per acre over this 11-year period.

It appears, therefore, that the average yield of this orchard under a program of permanent cover was nearly three times the average of all those studied, and over twice the average of the seven high pear orchards that were reported. The efficiency study also reports that this orchard produced the highest acre-yield and income of those investigated.

Pest control consists normally of eight applications of arsenate spray, the cost being about $20 per acre. This program is similar to that followed by other growers in the area who successfully control pests, particularly coddling moth. Coddling moth is the major pest on Bartlett pears in this area, and it is necessary to follow a consistent spray program in order to produce clean fruit. The amount of wormy fruit for the 1938 season was not obtainable; the owner stated, however, that no shipments had been rejected up to the time the inspection was made, and he believed the losses would not exceed 1 percent. Gophers and other rodents are satisfactorily controlled by traps and the flood irrigation which is practiced.

The owner is thoroughly satisfied with the results

Above. — Permanent cover with high production in a southern California avocado orchard.

Left.—Wild barley, bur clover and annual bromegrass form the cover in this fine lemon orchard, uncultivated for 15 years.

he is securing from his orchard under a program of permanent cover, and he intends to continue the practice. He definitely stated that it was his opinion that additional fertilization and pest control are not necessary under such a program.

Permanent Cover in Avocado Groves

In southern California there are many avocado growers who are using permanent cover in their groves. The data on one 15-acre grove, located on the Vista C. C. C. camp area near Fallbrook in San Diego County, will be included here. These avocado trees are 11 years old, and the soil has not been cultivated since the trees were planted. The cover crop consists of Bermuda grass, bur clover, and some annual weeds. The cover has never been mowed or disturbed except where a shovel was used to facilitate the flow of irrigation water.

The grower has used and observed three methods of irrigating. The irrigation water is applied through a system of furrows and basins, straight furrows, and under-tree sprinklers. He is of the opinion that the under-tree sprinkler is most satisfactory and he is installing such a system over the entire 15 acres at a cost of about $200 per acre.

The production of these trees is very satisfactory, as is the quality of the fruit, and the gross income for the year was $5,400. The crop history shows there has been progressive increase in the yield each year. The yield for 1936–37 averaged 5,512 pounds of first-

grade fruit per acre, which is above average for the area.

The pest control consists of a light dusting with sulphur about once a season at a cost not to exceed $5 per acre.

This grower is very enthusiastic about permanent cover and believes that his success in producing a high yield and quality of fruit can be partially attributed to the fact that he is not destroying by cultivation the high percentage of feeder roots located immediately under the cover.

There is no soil loss or any appreciable run-off resulting either from irrigation or winter rainfall, even under the occasional high intensity precipitation, from the slopes that range from 5 to 15 percent. The grower applies about 20 acre-inches of irrigation water from two wells at a cost of $6 per acre for power.

The fertilizer program consists of the application of about 10 tons of dairy manure to the acre every other year and 3 pounds of ammonium sulphate per tree annually. At current prices the cost is about $45 per acre. Considering the yield and quality of the fruit the expenditure appears warranted, but, in view of the experience of other growers, it is questionable whether the organic fertilizer is required.

Permanent Cover in Citrus Groves

The factual data have been collected from the records of six orange growers and three lemon growers who have had permanent cover without cultivation for 2-, 5-, 10-, and 15-year periods. The practices consist of annual volunteer cover with basin irrigation and overhead sprinklers, permanent cover of ryegrass with under-tree sprinkler, permanent cover of Bermuda grass with furrow, and basin and flooding irrigation, all without cultivation. One grower has found it profitable to pasture the permanent cover with geese, providing they are properly rotated to different areas in the orchard.

Data from at least two representative groves could be recorded, but it may suffice for the purpose of this article to state that none of the growers interviewed would change to his former clean-cultivated practices. One of the growers has had permanent cover for 15 years, following 10 years of annual cover crops and clean cultivation. This particular grove, Eureka lemon trees, planted in San Diego County in 1913, has the 500 original trees and this indicates that rodents have been successfully controlled. The production of 10 boxes per tree is above the average for the district.

A 29-acre orange grove planted in 1928 near Santa Paula, Ventura County, Calif., on slopes varying from 5 to 30 percent, with annual volunteer cover, no cultivation, and irrigated with an overhead sprinkler system, was reported to be the second highest yielding 10-year-old grove in the State last year.

Our observations on 23 permanent cover-cropped irrigated orchards that had been managed under this system for 2 to 22 years convince us that in no instance would the owner change to clean cultivated practices. It was found that the rather large cost item of cultivation has been reduced to a minimum, usually not to exceed $5 an acre, where formerly, as in one instance, the cultivation costs amounted to $65 per acre. The saving in this item may be held in reserve to offset any added cost which may develop from the use of a permanent cover.

The statements made in this paper are the results of a preliminary survey and, while suggestive and interesting, should not be construed as a recommendation of the general use of permanent cover crops in orchards. Additional work will be required before the relationship between permanent cover and pests, rodents, fire hazard, quality, and production can be determined and fully evaluated.

While further and more complete investigations would indicate many of the causes or reasons for the results as herein set forth, it should be remembered that our observations were for the purpose of making a preliminary determination of the value of permanent cover in erosion control.

Farmers on all Soil Conservation Service projects are seeking more efficient methods to conserve the soil. Wherever permanent cover crops are used, the practice is meeting with enthusiastic response.

Evaluation studies are being set up on the Soil Conservation Service projects and camp areas for the purpose of stimulating further thought and investigation of this fundamental soil conservation practice.

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ment of seed and also improved the absorptive power of the soil.

Bermuda grass sod (*Cynodon dactylon*) was used to stabilize and protect earthen structures from washing. The sods formed a solid mat on these structures in 1 year.

Plantings of willow, giant reedgrass, and batamony in the silt deposits above diversion dams, have formed a dense growth which aids greatly in dissipating the

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Collecting black locust seed in Lewiston, Idaho.

Hardiness of Southern Idaho Locust

DURING the past 3 years the Soil Conservation Service has secured by collection or purchase approximately 150,000 pounds of black locust seed. Most of it came from southern Idaho. This memorandum has been prepared in response to numerous inquiries as to hardiness to be expected of stock produced from southern Idaho seed.

Technicians of the nurseries section of the Pacific Northwest region are of the opinion that Idaho seed is the equal of and possibly superior to that available from any other known source. The seed is large, well developed, and averages an extremely high cutting test. Plantings to date have been very satisfactory.

A few data concerning site factors of Idaho locust may suggest additional reasons for considering this State as a desirable source for locust seed. The approximate elevation range for the area is 2,700 to 4,500 feet. The latitude is 43° N. The climatological data for Boise and Jerome Counties is shown below. Both counties are heavy seed producers.

	Boise County	Jerome County
Average elevation	2,700 feet	3,572 feet.
Average summer temperature	70.9° F.	67.6° F.
Average winter temperature	32.0° F.	25.9° F.
Average maximum summer temperature	85.9° F.	86.4° F.
Average minimum summer temperature	24.2° F.	16.0° F.
Highest summer temperature	121° F.	105° F.
Lowest winter temperature	−28° F.	−27° F.
Average date first fall killing frost	Oct. 13.	Sept. 20.
Average date last spring killing frost	Apr. 27.	May 20.
Average length growing season	169 days.	123 days.

These data indicate that hardiness is a prerequisite for plants grown in the area. Furthermore, it is believed that there is a direct parallelism between desirable cereal and tree seed sources. For the former it has been demonstrated that seed from plants grown under rigorous conditions in northern States or at high altitudes is more desirable than that produced by plants where conditions are less severe. Southern Idaho is a recognized seed producing area for forage and cereal crops, the seed finding a ready market throughout the United States.

Throughout the area under discussion it has been found that black locust trees are vigorous and rapid growers. They are remarkably free from parasites. Seed crops are certain, yields are high, quality is excellent; hence seed can be produced at low cost.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

HUMUS: ORIGIN, CHEMICAL COMPOSITION, AND IMPORTANCE IN NATURE.—SECOND EDITION. By Selman A. Waksman. Baltimore, Md. 1938.

Since the first edition of Dr. Waksman's book was reviewed for this department (July 1936 issue), it has been widely read and applied in the work of our Service. And now, but 2½ years after its original appearance, we have the extraordinary advantage of a revision which takes into account the rapidly growing recognition of the significance of organic matter in agricultural practice and soil conservation, particularly the latter.

The volume now may be considered a standard work of reference. It is a keen and critical interpretation of the facts concerning humus in the natural organic cycle with aspects for practical application of the knowledge. The logical order of arrangement, from "nature and characteristics and types of humus and its role in plant nutrition" to "humus and soil conservation," is an important feature, as it presents the highly complicated subject without confusion and points to the numerous special problems in such a manner that ready reference is facilitated.

There is an entirely new chapter in the second edition, and its title is "Humus and soil conservation." A great deal of pertinent information is packed into this chapter to show the relation of humus to soil fertility, the reason for humus losses through cultivation and through wind and water erosion, and the importance of, or rather the "prime necessity" for, constant maintenance of soil organic matter in a soil-conservation program.

To show that erosion of the soil as well as deterioration due to improper systems of cultivation are closely related to soil organic matter Dr. Waksman points to the results of 50 years of field experiments at the Woburn Experimental Station. These results, analyzed by Russell and Voelcker, are given in support of the conclusion that soil deterioration under continuous cropping can be prevented only by the use of farmyard manures with crop rotation. Going further, the author cites Richardson's "Nitrogen cycle in grassland soils," a 1938 publication, to emphasize the increase in organic matter content through use of lime. Continuing this line of reasoning, Dr. Waksman writes: "In semiarid areas, the alternate summer-fallow and wheat system of farming was found to be most destructive to the humus supply of the soil. In the application of organic residues to increase the humus content, it is essential to supplement low-nitrogen-containing materials, such as straw, with sufficient nitrogen, so that there is 1 part nitrogen for every 12 parts of carbon." And here is cited the recent article (1938) by Holtz and Vandecaveye, "Organic residues and nitrogen fertilizers in relation to the productivity and humus content of palouse silt loam."

The citation series throughout the book constitutes unusually interesting studies which reveal the author's ability for critical interpretation of all aspects of his subject. In this second edition he has used to advantage an enormous amount of literature on humus; in particular, he gives considerable space to the interpretation of the works of modern Russian writers. The bibliography has been enlarged to include most of this literature. There are now 1,608 references.

Chapter 8, under Origin and Nature of Humus, has been greatly enlarged to contain very valuable information about humus formation in composts of stable manure and of plant residues, and about the effects of green manure crops upon the soil.

For the benefit of those who are not acquainted with the first edition, the contents of the large volume is outlined briefly as follows: Humus in the organic cycle in nature. Nature and characteristics of humus, types, role in plant nutrition, changing conceptions concerning the chemical nature of humus and humic acids, and humification of organic matter in soils, and in composts with methods of determination. Origin of humus, isolation of definite organic chemical compounds from humus, chemical nature of humus, and humus formation in composts of stable manures and of plant residues, with studies of green manures. Humus in forest and heath soils, in mineral soils (field, grassland, garden, orchard), in peat and coal. Organic matter formations in water systems. Physical and physiochemical properties of humus. Decomposition of humus in nature, presence in humus of substances injurious and beneficial to the growth of higher plants. Utilization of various forms of humus for agricultural and industrial purposes. Soil humus and the science of pedology. Humus and soil conservation. Humus as an organic system. Methods of analysis of humus and of certain humus constituents.

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force of flood waters before they reach the structures as well as hastening the filling of the old arroyos themselves.

Treatment of the area is thus resulting in a two-fold benefit: (1) It is removing the silt and flood menace to irrigation ditches, farm lands, and storage reservoirs below, and (2) it is restoring the productivity of an area which had deteriorated as a result of severe arroyo cutting and sheet erosion and was consequently denuded of its cover of vegetation.

Careful studies conducted during the process of arroyo filling and land revegetation are proving to be extremely helpful in adding to our knowledge of the processes of sedimentation and erosion and also in pointing the way to improved methods for controlling erosion and conserving moisture in the Southwest.

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erosion is either prevented or stopped. It is first of all a matter of observation, and then of good judgment. An early recognition of trends in range conditions is a prerequisite to making timely adjustments. Constant endeavor must be employed in the proper handling of a grazing area, in pointing out to the operator the objectives of soil conservation in the field, and in instructing and guiding him in the principles of proper use.